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COMPARISON OF VARIOUS CHEMICAL TREATMENTS TO BREAK DORMANCY OF GLADIOLUS CORMS

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Gladiolus is commercially propagated through corms and occurrence of dormancy in freshly harvested corms creates hindrance in their cultivation. Present study was designed to compare the effect of different chemicals to alleviate the dormancy of corms in a short time. Gladiolus corms were collected from two growing sites and subjected to chemicals methanol, benzylaminopurine (BAP), gibberellic acid (GA_3), indole acetic acid (IAA), salicylic acid, potassium nitrate and thiourea at different concentrations alone or in combinations. The treated corms were planted on sand and placed under dark conditions at 26°C. The treatment of 60% methanol in combination with 0.9 mM BAP showed maximum germination (72.71%). Descaled corms showed 85% germination compared to 60.42% scaled corms, while the corms collected from Faisalabad showed better germination 83.75% compared to corms from Rawalakot (61.67%). The application of 60% methanol also induced 29.65% and 42.43% deterioration in scaled and descaled corms, respectively. The treatments of 0.3 mM BAP in combination with 0.6 mM GA_3 exhibited 88.33 % germination in corms collected from Faisalabad as compared to 55% in corms from Rawalakot. Overall, application of BAP and GA_3 in combination was found effective in shortening the period of dormancy in both cultivars of gladiolus compared to other tested chemicals or growth regulators.
Keywords: Cut flowers, dormancy, Amsterdam, corm, growth regulators, methanol, white prosperity.

INTRODUCTION

Flower bulbs are often known as ornamental geophytes (Halevy, 1990; De Hertogh and Le Nard, 1993) possessing great diversity in their morphology, growth and development. There are more than 800 genera which belong to ornamental geophytes, among which seven genera are dominated in bulbous cut flower industry including Lilium, Narcissus, Tulips, Gladiolus, Hyacinthus, Crocus and Iris. Gladiolus is perennial bulbous flowering belongs to family Iridaceae and found in most countries of the world. The genus gladiolus consists of about 260 species, among which 250 species belong to sub-Saharan Africa and 10 species are native to Eurasia (Goldblatt and Manning, 1998; Manning and Goldblatt, 2008).

Plants form underground structures such as tubers (Hyacinthus), rhizomes (Iris) and corms (gladiolus) before the occurrence of unfavorable growth conditions (Rohde and Bhalerao, 2007). Commercially, the gladiolus is cultivated and propagated asexually by mean of corms. Corm is underground modified stem that provide nutrients during sprouting (Ghamsari *et al.*, 2007). After the senescence of above ground parts of gladiolus plants, the lifted corms from soil are unable to germinate under favorable environmental conditions due to occurrence of dormancy. Dormancy is the characteristic feature of gladiolus corms (Hosoki, 1984). There are usually three types of dormancy on the basis of factors responsible for dormancy; the endodormancy refers to presence of dormancy controlling factors inside the dormant structure including seeds, buds, corms and other vegetative organs, paradormancy exists due to inhibition caused by external plant structure and ecodormancy represents the inhibitory environmental conditions (Lang, 1987), and in gladiolus corms exist endodormancy.

There are different approaches being used to break the dormancy such as scarification, stratification and use of different chemicals including the plant growth regulators in different plants. The effectiveness of each method depends on the type and depth of dormancy in the targeted plant. The dormant corms or seeds need cold treatment for long period of time to break dormancy which is a limiting factor in this approach (Dole, 2003). On the other hand, plant growth regulators such as benzyladenine, gibberellic acid and indole

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acetic acid have been reported to short the dormant period by facilitating germination (Hilhorst and Karssen, 1992; Iglesias and Babiano, 1997; Cirak *et al*., 2007; Finkelstein *et al*., 2008). Exogenous application of gibberellic acid is an alternative of cold treatment and effective in shortening the dormancy period of gladiolus corms (Ginzburg, 1974; Tonecki, 1980; Bhattacharjee, 1984; Dua *et al*., 1984). The usage of chemicals like salicylic acid, thiourea and potassium nitrate has been reported to short the dormancy period (Padmalatha *et al*., 2013). The dormancy status in gladiolus corms may depend on the cultivars and also the environmental conditions in which they are grown. The same cultivars may differ in their state of dormancy when grown under different environmental conditions (Paswan, 1985).

In literature, efficacy of different dormancy breaking chemicals has been reported but little investigation has been found on the role of gladiolus growing conditions and depth of dormancy. The present study is focused on the comparison of treatment of different chemicals in various combination to break dormancy in gladiolus cultivars that were collected from different ecological zones

MATERIALS AND METHODS

***Corm source*:** The gladiolus corms were taken from two different areas, Rawalakot and Faisalabad, having different climatic conditions. Rawlakot is famous for commercial cultivation of gladiolus and located at 33°- 51' N latitude, 73°- 45' E longitude and 1638 m altitude. The freshly harvested corms were taken from Rawlakot and transported to the laboratory. Faisalabad city is located in the Punjab province of Pakistan. The gladiolus corms were harvested from the Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. The field area was located at 31°- 26' N latitude, 73°- 06' E longitude and 184.4m altitude (Fig.1).

***Treatments for experiments*:** In the first experiment, after shifting corms from both sources to the laboratory, the corms were prepared for treatments. The scales were removed from half of the corms from each source. The scaled and descaled corms of both varieties, White Prosperity and Amsterdam, were first dipped in 0% (distilled water only), 30% and 60% of methanol separately for 12 hours. Then, after taking out corms from methanol, the corms were dipped in solutions of either gibberellic acid (GA_3), 6-benzylaminopurine (BAP) or indole acetic acid (IAA) at 0.3, 0.6 and 0.9 mM concentrations for 15 hours, separately. The corms dipped in water were treated as control corms.

In the second experiment, the corms of two gladiolus varieties, White Prosperity and Amsterdam, were collected from two sites, Rawlakot and Faisalabad, were descaled and

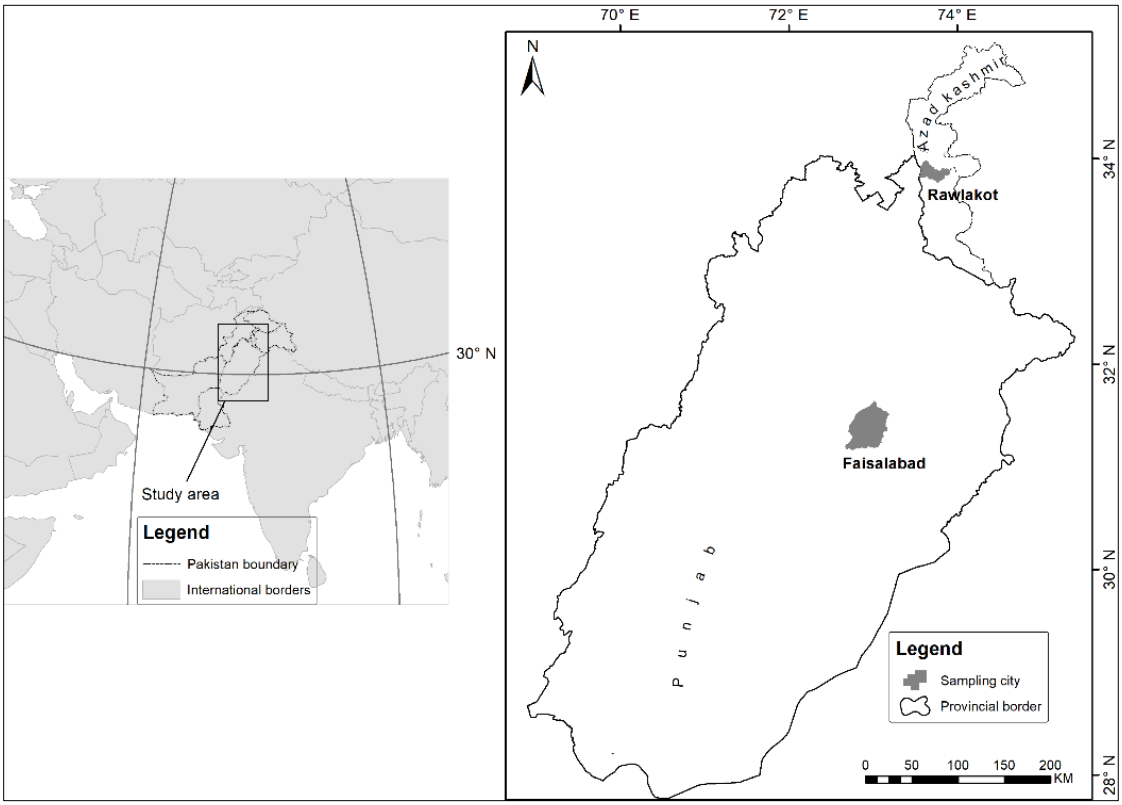

Figure 1. Geographic location of corms sources including Rawalakot and Faisalabad.

dipped in solutions of indole acetic acid or 6-benzylaminopurine at concentrations of 0.1, 0.2 or 0.3 mM for 10 hours, separately. Then, the corms were shifted to 0.2, 0.4 or 0.6 mM solutions of gibberellic acid for the next 15 hours.

In the third experiment, the freshly harvested corms of two gladiolus varieties, White Prosperity and Amsterdam, were collected from two sites, Rawlakot and Faisalabad, were descaled and dipped in solutions of salicylic acid, thiourea or potassium nitrate for 10 hours, separately at 0.5, 1.0, 1.5 or 2.0% concentrations.

***Growth conditions*:** After receiving treatments in all experiments, the treated and untreated corms were shifted in pots containing sand. After that, these pots were placed in growth room at 26°C under dark conditions.

Corm decaying percentage: This parameter was recorded for first experiment only. The corms which showed symptoms of deterioration were marked as decayed corms and their number was recorded at the end of experiment and percentage was calculated. The corm decaying percentage indicated the overall decay in scaled and descaled corms in response to different concentrations of methanol treatment.

***Germination percentage*:** The germination of corms was recorded when the buds sprouted up to 0.5 cm (Tsukamoto, 1972). Total germination percentage was recorded after 3 weeks of treatments in all the experiments.

***Experimental design and statistical analysis*:** The experiment was conducted in a Completely Randomized Design (CRD) in growth room under controlled conditions. The treatments were replicated thrice and there were 10 corms planted in each replication. The data was subjected to an analysis of variance as applicable to factorial CRD by using Statistix software and treatment means were compared by using Duncan's Multiple Range test (DMR) at 5% probability level.

RESULTS

In the first experiment, the benzylaminopurine alone showed the maximum increase in germination percentage (53.13%)

Table 1. Effect of chemicals on germination percentage of dormant scaled and descaled corms.

Methanol (%)	GA_3 (mM)	BAP (mM)	IAA (mM)	Germination (%)	Scaled	Descaled
T1	0	0.3			30.00 m	24.58 za	35.42 s-v
T2	0	0.6			37.71 kl	32.50 u-x	42.92 k-p
T3	0	0.9			42.71 ij	38.33 p-t	47.08 h-k
T4	0		0.3		39.17 k	32.50 u-x	45.83 j-m
T5	0		0.6		48.13 g	42.08 l-q	54.17 fg
T6	0		0.9		53.13 f	46.67 i-l	59.58 e
T7	0			0.3	24.79 n	18.33 b	31.25 vwx
T8	0			0.6	35.42 l	29.58 wxy	41.25 m-r
T9	0			0.9	40.00 jk	33.75 t-w	46.25 jkl
T10	30	0.3			37.50 kl	31.25 vwx	43.75 k-o
T11	30	0.6			47.50 gh	40.83 n-r	54.17 fg
T12	30	0.9			53.13 f	46.25 jkl	60.00 e
T13	30		0.3		49.17 g	38.33 p-t	60.00 e
T14	30		0.6		56.88 de	47.08 h-k	66.67 cd
T15	30		0.9		61.04 c	51.67 gh	70.42 bc
T16	30			0.3	31.67 m	25.42 yza	37.92 qrst
T17	30			0.6	38.75 kl	32.08 vwx	45.42 j-n
T18	30			0.9	44.17 hi	37.08 r-u	51.25 ghi
T19	30				26.46 n	20.83 ab	32.08 vwx
T20	60	0.3			47.29 gh	40.83 n-r	53.75 fg
T21	60	0.6			55.42 ef	45.42 j-n	65.42 d
T22	60	0.9			60.21 cd	50.00 g-j	70.42 bc
T23	60		0.3		59.58 cd	45.83 j-m	73.33 b
T24	60		0.6		67.92 b	54.58 fg	81.25 a
T25	60		0.9		72.71 a	60.42 e	85.00 a
T26	60			0.3	40.00 jk	34.17 t-w	45.83 j-m
T27	60			0.6	49.17 g	40.00 o-s	58.33 ef
T28	60			0.9	54.38 ef	45.83 j-m	62.92 de
T29	60				39.38 jk	28.75 xyz	50.00 g-j

Means sharing the same letter do not differ by DMR test at $p < 0.05$; GA_3: gibberellic acid, BAP: benzylaminopurine, IAA: indole acetic acid.

Table 2. Effect of varieties, descaling and corm source on germination percentage of gladiolus corms.

Varieties		Scales		Corm Source	
Amsterdam	**White prosperity**	**Scaled**	**Descaled**	**Rawalakot**	**Faisalabad**
48.65 a	43.99 b	38.45 b	54.19 a	34.96 b	57.69 a

followed by gibberellic acid (42.71%) and indole acetic acid (40%) treatment at 0.9 mM concentration (Table 1). The effect of treatments was more pronounced in combination of methanol with the plant growth regulators rather their alone application. The methanol at 60% strength in combination with 0.9 mM benzylaminopurine showed the highest increase in germination percentage (72.71%) among all the treatments.

In interaction between treatments and scales, the response of descaled corms was better in all the treatments as compared to scaled corms (Table 1). It was observed that germination percentage was increased as the concentration of methanol was increased. At 30% methanol in combination with 0.9 mM of benzylaminopurine, the germination percentage was recorded (51.67%) in scaled and 70.42% in descaled corms which was increased to 60.42% and 85.0%, respectively, at 60% methanol in combination with 0.9 mM benzy laminopurine.

Table 3. Effect of chemicals and corm source on germination percentage of dormant corms.

	Methanol (%)	**GA_3 mM**	**BAP mM**	**IAA mM**	**Rawalakot**	**Faisalabad**
T1	0	0.3			21.25 cd	38.75 tuv
T2	0	0.6			30.00 x-a	45.42 p-s
T3	0	0.9			35.00 uvw	50.42 l-o
T4	0		0.3		25.00 bc	53.33 klm
T5	0		0.6		35.00 uvw	61.25 j
T6	0		0.9		40.00 t	66.25 f-i
T7	0			0.3	20.00 d	29.58 y-b
T8	0			0.6	30.00 x-a	40.83 st
T9	0			0.9	34.17 v-y	45.83 o-r
T10	30	0.3			27.08 ab	47.92 nop
T11	30	0.6			33.75 wxy	61.25 j
T12	30	0.9			39.58 tu	66.67 e-h
T13	30		0.3		34.17 v-y	64.17 g-j
T14	30		0.6		42.50 qrst	71.25 cde
T15	30		0.9		47.08 n-q	75.00 bc
T16	30			0.3	20.83 cd	42.50 qrst
T17	30			0.6	28.75 zab	48.75 m-p
T18	30			0.9	34.17 v-y	54.17 kl
T19	30				18.33 d	34.58 vwx
T20	60	0.3			32.92 w-z	61.67 ij
T21	60	0.6			41.25 rst	69.58 def
T22	60	0.9			46.25 n-q	74.17 cd
T23	60		0.3		48.75 m-p	70.42 c-f
T24	60		0.6		56.25 k	79.58 ab
T25	60		0.9		61.67 ij	83.75 a
T26	60			0.3	26.67 ab	53.33 klm
T27	60			0.6	35.00 uvw	63.33 hij
T28	60			0.9	40.42 t	68.33 efg
T29	60				27.92 ab	50.83 lmn

The corms of gladiolus variety Amsterdam showed more positive results in breaking their dormancy in response to application of chemicals and gave 48.65% germination in comparison with corms of White Prosperity (43.99%) (Table 2). The descaled corms were more responsive to chemical application (Table 2) and showed an increase in germination percentage (54.19%) compared to corms with intact scales (38.45%). The corms taken from Faisalabad showed maximum increase in germination percentage (57.69%) while corms from Rawalakot exhibited less response to application of chemicals and gave 34.96% germination (Table 2).

The interaction between treatments and corm source was also found significant and the corms taken from Faisalabad performed better and resulted in an increase of germination percentage while the corms taken from Rawalakot showed less response to treatments. Table 3 showed the minimum germination percentage (20.0%) in corms of Rawalakot and 29.58% in corms taken from Faisalabad in response to application of 0.3 mM indole acetic acid. The maximum germination percentage (83.75%) was recorded in corms of Rawalakot at 60% methanol in combination with 0.9 mM benzylaminopurine application. In interaction of treatments, scales and corm source, Table 4 indicates the superiority of descaled corms over scaled corms and Faisalabad source over Rawalakot. The maximum increase in germination (95.83%) was recorded in descaled corms of Faisalabad source in response to application of methanol at 60% in combination with 0.9 mM benzylaminopurine. Overall the methanol at 60% concentration in combination with 0.3, 0.6 and 0.9 mM concentration of benzylaminopurine and gibberellic acid was good in breaking the corm dormancy of descaled corms of Faisalabad source.

Table 4. Effect of chemicals, corm source and scales on germination percentage of dormant corms.

Methanol		GA_3	BAP	IAA	Rawlakot		Faisalabad	
%		mM	mM	mM	Scaled	Descaled	Scaled	Descaled
T1	0	0.3			16.67 qr	25.83 k-o	32.50 f-k	45.00 x-a
T2	0	0.6			25.00 l-o	35.00 c-h	40.00 z-e	50.83 s-x
T3	0	0.9			30.83 g-l	39.17 a-f	45.83 w-a	55.00 p-u
T4	0		0.3		19.17 o-r	30.83 g-l	45.83 w-a	60.83 k-p
T5	0		0.6		30.83 g-l	39.17 a-f	53.33 q-v	69.17 g-j
T6	0		0.9		35.00 c-h	45.00 x-a	58.33 m-r	74.17 efg
T7	0			0.3	13.33 r	24.17 l-p	23.33 m-q	35.83 b-g
T8	0			0.6	24.17 l-p	34.17 d-i	35.00 c-h	46.67 v-z
T9	0			0.9	25.83 k-o	39.17 a-f	41.67 z-c	50.00 t-x
T10	30	0.3			20.83 n-q	33.33 e-j	41.67 z-c	54.17 p-u
T11	30	0.6			27.50 i-n	40.00 z-e	54.17 p-u	68.33 g-j
T12	30	0.9			32.50 f-k	46.67 v-z	60.00 l-q	73.33 e-h
T13	30		0.3		26.67 j-n	41.67 z-c	50.00 t-x	78.33 def
T14	30		0.6		35.83 b-g	49.17 u-y	58.33 m-r	84.17 cd
T15	30		0.9		40.83 z-d	53.33 q-v	62.50 j-o	87.50 bc
T16	30			0.3	17.50 pqr	26.67 j-n	33.33 e-j	51.67 r-x
T17	30			0.6	23.33 m-q	35.83 b-g	40.83 z-d	56.67 n-t
T18	30			0.9	29.17 g-m	42.50 y-b	45.00 x-a	63.33 j-n
T19	30				13.33 r	23.33 m-q	28.33 h-m	40.83 z-d
T20	60	0.3			25.83 k-o	40.00 z-e	55.83 o-u	67.50 g-k
T21	60	0.6			30.83 g-l	51.67 r-x	60.00 l-q	79.17 de
T22	60	0.9			35.83 b-g	56.67 n-t	64.17 i-m	84.17 cd
T23	60		0.3		34.17 d-i	63.33 j-n	57.50 m-s	83.33 cd
T24	60		0.6		41.67 z-c	70.83 ghi	67.50 g-k	91.67 ab
T25	60		0.9		49.17 u-y	74.17 efg	71.67 fgh	95.83 a
T26	60			0.3	22.50 m-q	30.83 g-l	45.83 w-a	60.83 k-p
T27	60			0.6	27.50 i-n	42.50 y-b	52.50 r-w	74.17 efg
T28	60			0.9	34.17 d-i	46.67 v-z	57.50 m-s	79.17 de
T29	60				22.50 m-q	33.33 e-j	35.00 c-h	66.67 h-l

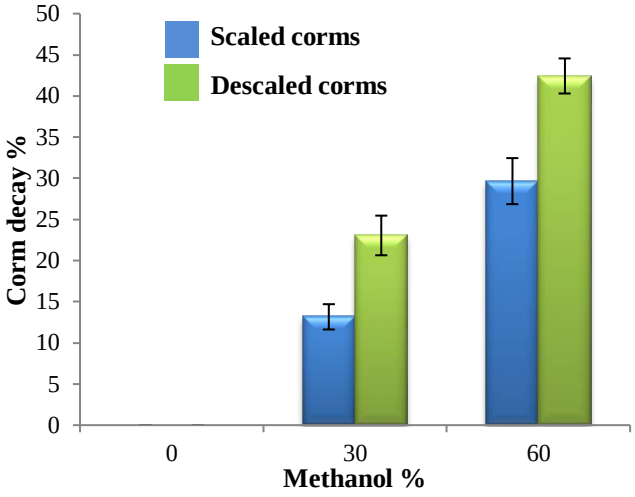

Figure 2. Effect of methanol treatment on decay percentage of scaled and descaled gladiolus corms.

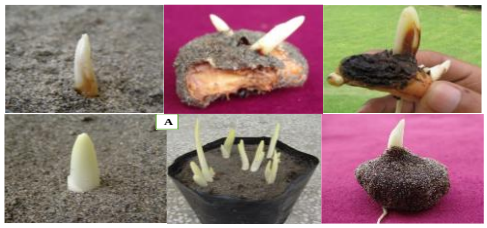

Figure 3. (A) Normal germination of dormant corms in response to application of plant growth regulators; (B) Deterioration of corms in response to application of methanol. The deterioration of corms was observed in both varieties due to application of long exposure of methanol. The deterioration effect of methanol on scaled and descaled corm is mentioned in Figure 2 and 3B. The descaled corms were more sensitive to application of methanol compared to scaled corms. Methanol application at 30% concentration showed 13.16% and 29.65% decay in scaled and descaled corms, respectively, which was increased to 29.65% and 42.43% decay at 60% methanol treatment (Fig. 2).

Table 5. Effect of chemicals and corm source on germination of dormant corms.

Treatments	BAP (mM)	IAA (mM)	GA_3 (mM)	Germination (%)	Rawlakot	Faisalabal
T1	0.1		0.2	45.00 f	30.00 n-q	60.00 gh
T2	0.2		0.2	52.92 e	33.33 l-p	72.50 cde
T3	0.3		0.2	59.58 c	41.67 jk	77.50 bc
T4		0.1	0.2	21.25 j	15.83 s	26.67 qr
T5		0.2	0.2	30.00 i	23.33 r	36.67 klm
T6		0.3	0.2	35.00 gh	29.17 o-r	40.83 jk
T7	0.1		0.4	51.67 e	35.83 k-n	67.50 ef
T8	0.2		0.4	59.17 cd	41.67 jk	76.67 bcd
T9	0.3		0.4	65.42 b	48.33 i	82.50 ab
T10		0.1	0.4	31.67 hi	25.00 qr	38.33 jkl
T11		0.2	0.4	36.25 g	28.33 o-r	44.17 ij
T12		0.3	0.4	43.33 f	30.83 m-q	55.83 h
T13	0.1		0.6	55.00 de	39.17 jkl	70.83 def
T14	0.2		0.6	64.17 b	48.33 i	80.00 b
T15	0.3		0.6	71.67 a	55.00 h	88.33 a
T16		0.1	0.6	37.92 g	27.50 pqr	48.33 i
T17		0.2	0.6	46.25 f	34.17 l-o	58.33 h
T18		0.3	0.6	51.67 e	38.33 jkl	65.00 fg

In the second experiment, there was no germination observed in untreated corms even after 3 weeks. Gibberellic acid at 0.2 mM concentration in combination with 0.1 mM benzylaminopurine showed 45% germination which was increased to 59.58% at 0.3 mM concentration of benzylaminopurine. Indole acetic acid at 0.3 mM concentration in combination with 0.2 mM gibberellic acid exhibited 35% germination. The maximum germination percentage (71.67%) was recorded in corms treated with 0.6 mM gibberellic acid in combination with 0.3 mM benzylaminopurine (Table 5).

The interaction of treatments and corm source is given in Table 5, which shows that the corms taken from Faisalabad exhibited pronounced increase in germination percentage compared to corms from Rawalakot. The highest increase in corm germination percentage (88.33%) was observed in corms of Faisalabad which were treated in combination of 0.6mM gibberellic acid with 0.3mM benzylaminopurine.

The corms of gladiolus variety Amsterdam indicated better germination percentage (51.20%) compared to corms of White Prosperity (44.12%). The corms taken from Rawalakot had 34.77% germination which was much less than Faisalabad (60.55%) (Table 6).

Table 6. Effect of varieties and corm source on germination percentage of gladiolus corms.

Varieties		Corm Source	
Amsterdam	**White prosperity**	**Rawalakot**	**Faisalabad**
51.20 a	44.12 b	34.77 b	60.55 a

In the third experiment, the treatment of dormant corms with salicylic acid increased germination percentage followed by thiourea and potassium nitrate (Table 7). The maximum germination percentage (49.58%) was recorded in 2% salicylic acid followed by 49.17% in 2% thiourea treatment. The potassium nitrate at 2% treatment showed 41.67% germination.

Corms of Amsterdam were more responsive to treatments compare to White Prosperity and showed 38.27% germination compared to 34.24%, respectively (Table 8). The corms taken from Rawalakot showed low germination percentage (28.96%) compared to 43.54% exhibited by corms from Faisalabad.

Table 7. Effect of treatments on germination of dormant corms.

Treatments	(%)	Germination (%)
Salicylic acid	0.5	30.42 e
	1.0	35.42 cd
	1.5	43.33 b
	2.0	49.58 a
Thiourea	0.5	22.92 f
	1.0	32.92 cde
	1.5	43.33 b
	2.0	49.17 a
Potassium nitrate	0.5	19.58 f
	1.0	30.83 df
	1.5	35.83 c
	2.0	41.67 b

Table 8. Effect of varieties and corm source on germination percentage of gladiolus corms

Varieties		Corm Source	
Amsterdam	**White prosperity**	**Rawalakot**	**Faisalabad**
38.27 a	34.24 b	28.96 b	43.54 a

DISCUSSION

Benzylaminopurine has been reported to break the dormancy of those plants which are propagated vegetatively through their underground structures including gladiolus corms. The results are in line with the findings of Tsukamoto (1972) that dormancy of gladiolus corms was alleviated when soaked in solution of benzyladenine. Similarly, Thohirah *et al*. (2010) studied the effects of application of benzylaminopurine in breaking the dormancy of rhizomes of curcuma. Other plant growth regulators like gibberellic acid and indole acetic acid are also helpful in breaking the primary dormancy in gladiolus corms. The effectiveness of gibberellic acid (GA_3) in controlling the primary dormancy and the role of indole acetic acid to break the dormancy by prompting the process of germination has been proposed by Iglesias and Babiano (1997), and Hilhorst and Karssen (1992). Promotive effect of gibberellic acid is reported by Arnold *et al.* (1996) that exogenous application of gibberellic acid to the dormant seeds of chaenorrhinum is effective to break the dormancy and this may be due to elimination of their natural chilling requirement. The exposure time is also important to increase the effectiveness of growth regulators as Langens-Gerrits *et al*. (2003) found in their study that application of GA_3 to dormant bulblets of lily for long time (24 h) is helpful in increasing the germination percentage.

Descaling of corms also increased the germination percentage which indicates that the descaled corms gave more response to combined application of methanol and plant growth regulators as compared to scaled corms. Hosoki (1983) while working on gladiolus corms dormancy observed that the hulled corms showed early sprouting as compared to intact corms. Similar results were also presented by Imanishi (1981) in cormels of gladiolus and found that the cormels in which outer shell was removed showed early and more germination.

The application of benzylaminopurine (BAP) in combination with gibberellic acid was also effective in increasing the germination percentage of dormant corms of gladiolus. The results are supported by the findings of Low (1975) that application of cytokinin in combination with gibberellic acid increases the growth of lateral buds of *Phaseolus vulgaris*. Similarly, Kefeli (1978) mentioned that there is an interaction between cytokinins and gibberellic acid, and suggested that cytokinins function better in combination with other growth regulators. Kucera *et al.* (2005) reported that cytokinin interact with other growth regulators in dormancy and germination regulation process.

Reduction in dormancy period has been achieved with the application of salicylic acid and thiourea. Potassium nitrate also affected the germination percentage of gladiolus corms but their effect was low than salicylic acid and thiourea. The involvement of these chemicals to alleviate corm dormancy has been reported by Padmalatha *et al.* (2013). Abscisic acid is considered one of the principle inhibitor involved in the dormancy of gladiolus corms and cormels (Tsukamoto, 1975; Jung *et al*., 2000). Ray and Laloraya (1984) found that salicylic acid can reverse the physiological effects promoted by abscisic acid in several plant species.

Our results showed that the Amsterdam variety exhibited more germination percentage as compared to White Prosperity. Both varieties behaved somewhat differently to the same treatments which may be due to difference in state of dormancy occurred in each variety. The depth of dormancy may depend on the variety which can ultimately affect the response of that variety to the treatments. A similar relationship was found by Imanishi (1981) that the dormancy of gladiolus cormels is depended on cultivars.

Regarding corm source, the corms which were taken from Faisalabad responded more efficiently to treatments and showed higher germination than corms from Rawalakot. The source represents the difference in environmental conditions in which gladiolus corms were grown and corms were harvested. Faisalabad and Rawalakot are located geographically at different position and also had difference in environmental conditions. So the source of corms affected the breakdown of dormancy and these results are supported by Tsukamoto (1972) who found that the corms of gladiolus taken from different sources responded differently to the dormancy breaking chemicals. The difference in the response of corms to treatments taken from different sources may be due to the variation in the state of dormancy exhibited by corms taken from two different locations of different climate. The temperature is one of the important climatic factors which may affect the state of dormancy, i.e. the induction and release of dormancy (Delvallée *et al*., 1990; Langens-Gerrits *et al*., 2001). Low temperature induces dormancy in underground structures of bulbous plants including *Allium sativum* (Aoba, 1971), tulips (Le Nard and Cohat, 1968; Aoba, 1976) and *Lilium longiflorum* 'Hinomoto' (Okubo *et al*., 1988). The gladiolus corms taken from Rawalakot may have in deep dormant state as the climate of Rawalakot is cold compared to Faisalabad.

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